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# Ecological Evaluation of Shifting Habitat History for Riverbed Management( Abstract_要旨 )

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CITATION:

Hyodo, Makoto. Ecological Evaluation of Shifting Habitat History for Riverbed Management. 京都大学, 2015, 博士(工学)

ISSUE DATE:

2015-09-24

URL:

https://doi.org/10.14989/doctor.k19293

RIGHT:

許諾条件により本文は2016-09-24に公開

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| 論文題目 | Ecological Evaluation of Shifting Habitat History for Riverbed Management<br>（河床地形管理のための生息場履歴の生態的評価） | | |

（論文内容の要旨）

Various habitat evaluation tools have been adopted in decision-making processes in flood and water resources management. However, these tools have not addressed spatiotemporal patterns of habitats, even though they change drastically due to natural disturbances. Recent studies on shifting habitat state and habitat age in the Tagliamento River, North Italy, have indicated that various habitat types with different habitat age are required for biodiversity conservation. However, they have neither shown temporal variables of habitats nor tracked changing patterns of each habitat with shifting history. Thus, evaluation of shifting habitat history is required for ecological evaluation of the river environment. Objectives of this study are 1) to analyze relations of habitat suitability to sediment transfer and flood intensity and frequency, 2) to develop tools for evaluating ecological functions, and lastly 3) to propose basic approaches for applying the tools to riverbed management at a practical level.

This study was conducted in the Tenryu river, showing active riverbed changes with creation and elimination of habitats under various ranges in disturbance regimes. Installment of several interval-cameras at 50 m above the riverbed on the electric transmission tower was a strong device to record hourly shifting habitat history. Very intensive field monitoring on physical conditions and sampling of macro-invertebrates were conducted on the riverbed almost every two month. Then, relationships among physical conditions of habitats, responses of benthic organisms and habitat ages were analyzed. The thesis is composed of seven chapters as follows.

In Chapter 1, a review on ecological evaluation tools and previous studies was conducted to discuss the importance of shifting habitat history in ecological evaluation of the river environment.

In Chapter 2, previous works on ecological restoration of river corridor habitats, particularly through channel widening and creating secondary channels were reviewed. Well-known restoration projects were selected including case studies in USA, Europe and Japan. Most of them showed spatial distribution of habitat structure but not temporal variables reflecting the history of habitat changes in spite of their importance in ecological restorations. Therefore, “habitat diversity hypothesis” was proposed as a new approach to ecological evaluation of shifting habitats history. It hypothesized that biodiversity of stream ecosystem is determined by spatiotemporal patterns of habitat structure reflecting intensity and frequency of disturbances and resultant habitat ages.

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In Chapter 3, spatiotemporal patterns of aquatic habitats were quantitatively analyzed to describe shifting habitat history in relation to disturbance regimes. Shifting habitat history was recorded at 16.4 km-point of the Tenryu river in Japan, using interval-recording cameras installed at the electric transmission tower located in the middle of the river channel. Patterns of the shifting habitat history were analyzed based on those photo data in relation to deposition and erosion areas under different disturbance regimes, and thereby discussions were made on roles of small, middle and large flood disturbances in formation and conditioning of stream habitats.

In Chapter 4, formation and conditioning processes of spawning redds of Ayu fish, *Plecoglossus altivelis altivelis,* were investigated in relation to the shifting habitat history in the Tenryu River using the interval-recording cameras and field measurement of the riverbed environmental conditions. Suitable spawning redds for Ayu fish were found at two locations within the photo frame of interval-recording cameras installed. The shifting habitat history of these spawning redds was analyzed in relation to microhabitat environmental conditions such as substrate grain size, riverbed softness and DO concentration of interstitial waters in the riverbed. The results indicated that suitable spawning redds will be created during large flood disturbances and will be degraded during middle and small floods, indicating that suitable spawning redds are ephemeral habitats and therefore they depends on timing and intensity of disturbances.

In Chapter 5, analyses of habitat age effects on biodiversity of macro-invertebrates were made were analyzed based on the interval-camera images and field survey data. The results presented that macro-invertebrates showed species-specific changes in spatio-temporal distribution in lotic and lentic habitats during flood disturbances. Relations between the species diversity and habitat ages indicated the diversity of habitats with different ages within a reach is important for sustaining biodiversity and that small, middle and large floods are essential as maintenance mechanisms of the habitat age diversity.

In Chapter 6, methodologies for ecological evaluation of shifting habitat history and for application to riverbed management at a practical level were proposed and perspectives on cooperation between the sediment and flood control management and environmental riverbed management were discussed.

In Chapter 7, importance of historical approaches of habitat structure and their application to riverbed management were concluded.

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（論文審査の結果の要旨）

本論文は，河川環境評価において，生息場の時間的履歴に着目し，生息場を形成する土砂移動や洪水規模・頻度の役割，及び現場の生物の応答を分析することにより，洪水撹乱の生態的機能を評価するための手法を開発し，それらに基づいた生息場履歴の評価手法を現場の河床地形管理に応用するための考え方と手法を提案したものである．論文は 7 章から構成されている．

第 1 章では，河川環境における生息場の既存の評価手法や既往研究についてレビューを行い，生態的評価を行う上で生息場の時間的変化を評価する必要性について論じている．

第 2 章では，国内外の河川環境における生息場の生態的評価の事例をレビューし，評価における課題の抽出を行い，新たなアプローチとして Habitat diversity hypothesis（生息場多様性仮説）を提示するとともに，生息場変化履歴や生息場齢（生息場の存続時間：Habitat-age）に着目する必要性について論じている．

第 3 章では，河床地形変化が大きい天竜川 16.4kp 周辺を研究対象地区として，送電鉄塔に設置したインターバル撮影機能付デジタルカメラを用いて生息場履歴を定量的に記述している．これらの画像を解析し，小・中・大規模洪水による地形変化特性を把握している．

第 4 章では，天竜川において実際にアユの産卵を確認した 2 箇所について，アユの好適な産卵床が形成される地形変化の履歴ならびに空間的な分布特性を示すことで，アユ産卵床の形成と維持に必要な生息場履歴の評価に成功している．

第 5 章では，天竜川の生息場履歴の研究対象地区を対象に，生息場の変化履歴に対する底生無脊椎動物群集の応答を分析している．その結果，河川生態系に生物多様性を維持する上で，生息場齢が多様であることが重要であり，小･中･大規模洪水がそれぞれ役割を果たしていることを示している．

第 6 章では，生息場履歴の生態的評価を河床地形管理に応用するための考え方と手法について論じている．また，治水対策の対象になるような大規模の洪水撹乱の役割が重要であることが分かったため，これらの土砂･流況レジームを考慮した河床地形管理について考察を行っている．

第 7 章では，本論文の主要な結論をまとめ，今後の課題について記述している．

本研究は，①様々な規模の撹乱が生じる天竜川をフィールドとし，②複数のインターバル撮影機能付きデジタルカメラを設置して生息場履歴を追跡し，③アユの好適な産卵床の形成に必要な生息場履歴特性を追究し，そして④底生無脊椎動物の採取と物理環境条件に関する継続的な調査に基づき種多様性に対する生息場履歴の影響を分析することによって，生息場履歴を介した洪水撹乱の生物多様性維持機構を明らかにすることに成功している．中でも生息場寿命の評価については，とくに高い新規性が認められる．さらに，新たに提案された河川環境評価の観点は，水工計画上，大いに寄与するものである．よって，本論文は博士（工学）の学位論文として価値あるものと認める．また，平成 27 年 8 月 26 日に，論文内容とそれに関連した事項について試問を行なった結果，申請者が博士後期課程学位取得基準を満たしていることを確認し，合格と認めた．